NAMRL-1219

USAARL
Serial No. 76-1

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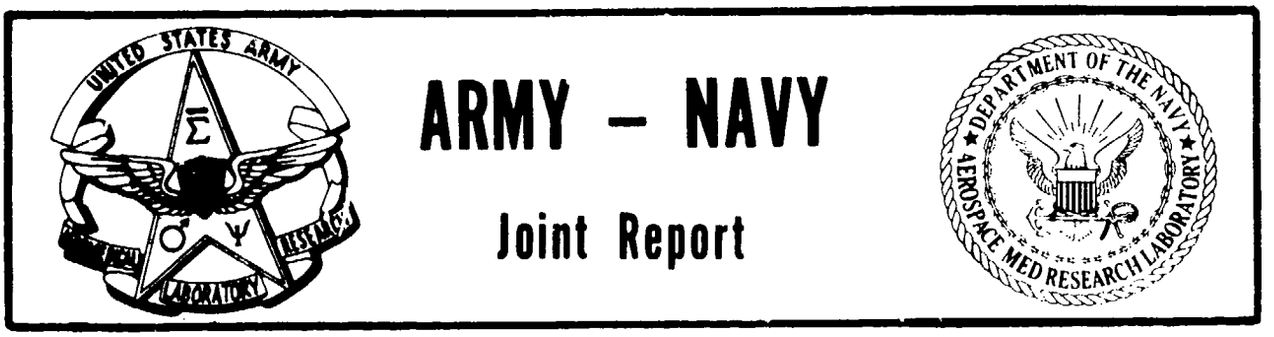
W. Carroll Hixson and Emil Spezia



U. S. ARMY AEROMEDICAL RESEARCH LABORATORY

NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY

July 1975

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MF51.524.005-7026

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SUMMARY PAGE

THE PROBLEM

From the military mission viewpoint, the amount of research effort to be expended on the solution of a given aviation medicine problem must be keyed to its operational cost. In the case of orientation-error accidents involving pilot disorientation and vertigo, little quantified data are available to describe either the incidence or cost of such accidents in aviation. In addition, though such accidents have been long recognized as a major aviation medicine problem, there are few data on hand to describe the direct operational setting for these accidents in terms of the pilot, aircraft, mission, and environmental factors which will be present, singly, or in some combination, for each mishap. Until such data are assimilated for a considerable number of orientation-error accidents, determination of the optimal solution route, whether it be, for example, aircraft design, cockpit layout, instrument concept, or matters dealing with pilot selection, training, and utilization, will not be achieved.

FINDINGS

To initiate the action necessary to establish the magnitude of the orientation-error problem in Army aviation, an interservice research program was organized under the joint sponsorship of the U. S. Army Aeromedical Research Laboratory, the U. S. Army Agency for Aviation Safety, and the Naval Aerospace Medical Research Laboratory. The first step was the construction of an operational definition of an orientation-error accident. The assimilation of data pertaining to the incidence and cause of such accidents and their actual and relative costs in terms of fatalities, injuries, and aircraft damage was then set as the working objective of the program using the master USAAAVS accident files as reference. Accordingly, the decision was made to implement a five-year longitudinal study of all major and minor orientation-error accidents involving Regular Army flight operations beginning with fiscal year 1967. Findings are being summarized on a fiscal-year basis in three separate lines of reports: The first line is devoted to defining the over-all magnitude of the orientation-error problem in all aircraft types; the second line to the presentation of similar incidence and cost data for accidents involving only the UH-1 aircraft, the predominant rotary wing aircraft in the Army inventory; and the third line to the description of the various pilot/operational factors found to be present in the major UH-1 orientation-error accidents.

This specific report is the fifth in the series dealing with UH-1 accident factors. A brief case history description is given of each major orientation-error accident which occurred in fiscal year 1971 along with various summary compilations of related background data including pilot experience, psychological and physiological stress variables, mission pressures, visibility conditions, materiel difficulties, facility limitations, and supervisory factors.

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The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

INTRODUCTION

To investigate the operational role of pilot disorientation and vertigo in the production of orientation-error type aircraft accidents, the authors have organized an interservice research program under the joint sponsorship of the U. S. Army Aeromedical Research Laboratory (USAARL), the U. S. Army Agency for Aviation Safety (USAAAVS), and the Naval Aerospace Medical Research Laboratory (NAMRL). Since little quantified data were available to describe the actual magnitude of the orientation-error problem in Regular Army flight operations, the decision was made to conduct a five-year longitudinal study, beginning with fiscal year 1967, of all Army aircraft accidents that involved an erroneous judgment of aircraft motion or attitude on the part of the pilot. Two separate, but related, project objectives were set for the longitudinal study. The first was to extract and assimilate the data from the USAAAVS master aircraft-accident files which would define the actual cost and relative cost of orientation-error accidents to Regular Army flight operations. These data, by defining the operational magnitude of the problem, would then serve to define the extent of the research support that should be devoted to its solution. The second working objective was to extract data on a case-history basis which would describe the various pilot/aircraft/mission/environment factors found to be present in each of the orientation-error accidents. Assimilation and analysis of these data over the study period would result in better knowledge of the most common operational causes of orientation-error accidents and thus point out those research directions which offer the greatest potential toward the reduction of accident incidence.

The results of the longitudinal study are being summarized in three separate lines of reports, with one report in each line prepared for each fiscal year of the five-year study. The first line of reports (for example, refs. 1,4,7,10, and 13) is devoted to defining the incidence and cost of all major and minor orientation-error accidents involving all aircraft types, fixed wing as well as rotary wing, that occurred in Regular Army flight operations for each fiscal year. Since the UH-1 "Huey" helicopter has been, and is, the predominant aircraft in the Army rotary wing inventory, the second line of reports (for example, refs. 2,5,8,11, and 14) is devoted to defining the magnitude of the orientation-error accident problem in only this aircraft. The layout and format of this line of reports are almost identical to those of the first line. The third line of reports (for example, refs. 3,6,9, and 12) deals exclusively with the various causal factors found to be present in all of the UH-1 major orientation-error accidents. Typical data to be presented include phase of flight, time of day, type of mission, pilot experience, physiological factors, psychological factors, facility factors, environmental factors, and the like.

This specific report is the fifth in the series dealing with accident factors and concerns only those major orientation-error accidents that occurred in UH-1 aircraft during fiscal year 1971. To facilitate the comparison of these factor data with similar data derived for other fiscal years of the longitudinal study, the layout and numbering of the figures presented in this report are identical to those presented previously (refs. 3,6,9, and 12). The various rationale involved in both the definition of the orientation-error class of accidents and the analysis of the related accident factors are discussed in

detail in the first report of the series (ref. 3). It is of particular importance that the reader recognize that the accident details contained in this report derive solely from the written records contained in the master file associated with each accident. Accordingly, the extent of the factors that can be listed for a given accident is dependent entirely on the extent of the documentation entered into the record by the field investigation team and its reviewing authorities.

PROCEDURE

A basic requirement for the commencement of this study was a workable definition of the class of accidents to be defined as involving orientation error. The reader is referred to previous reports (refs. 1,2, and 3) for a comprehensive definition and discussion of its rationale. Briefly, orientation is considered to involve the correct determination of the dynamic position and attitude of an aircraft in three-dimensional space. The key word here is dynamic, which implies that full knowledge of the motion as well as static attitude and position is required to define its instantaneous spatial orientation. Accordingly, a pilot is considered to have made an orientation error whenever his perception of the motion and attitude of his aircraft differs from the true motion or attitude, i.e., the true orientation of the aircraft. An orientation-error accident is then defined as one that occurs as a result of an incorrect control or power action taken by a pilot (or a correct action not taken) due to his incorrect perception (or lack of perception) of the true orientation of his aircraft.

With this definition of orientation-error accidents serving as a classification reference, an experienced classifier read all briefs in the USAAAVS master accident files and selected all major and minor accidents of this type occurring during fiscal year 1971. For redundancy, the entire accident files were also searched by sifting the coded summaries that USAAAVS prepares for each accident for a wide range of indicator terms.

The authors then reviewed the accident briefs independently for the purpose of establishing whether or not an orientation-error accident classification would result. In addition, the comprehensive master file on each suspect accident was obtained and reviewed. Whenever there was serious question as to the contribution of orientation error to the accident or where equally weighted alternative causal factors were present, then the accident was not included in the classification. The net effect of this policy is to give a conservative estimation of the magnitude of the orientation-error accident problem.

From the resulting listing of all major and minor orientation-error accidents that occurred in both fixed wing and rotary wing aircraft, separate identification was made of only those major accidents that occurred in UH-1 aircraft. The master file on each of these UH-1 accidents was then obtained from USAAAVS for review as described previously (ref. 3). In brief, the basic factor data were extracted from the files by the classifier using a combination check-list/narrative type questionnaire developed by the authors of this report. In addition, the classifier and the authors prepared independent

check-list summaries of selected accident details represented by the factors data compiled in figures shown later in this report.

RESULTS AND DISCUSSION

The accident data presented in this report pertain to 31 major orientation-error accidents that occurred in Regular Army UH-1 helicopters during fiscal year 1971. Of this total, 15 (48.4 percent) accidents involved one or more fatalities and 24 (77.4 percent) resulted in total strike damage to the aircraft. These accidents accounted for 44 fatalities, 18 major injuries, and 34 minor injuries.

The layout and format of related data to be presented in this report follow those utilized in previous reports (refs. 3,6,9,12) of this series. Figure 1 summarizes the incidence of fatal accidents, aircraft strikes, day accidents, and night accidents; incidence according to flight phase; and incidence according to assigned mission. In Figure 2A a distribution is given of the number of accidents that occurred during each month of the fiscal year. The incidence of these accidents on a local-time basis is described by the distribution shown in Figure 2B. Comparative cost and flight phase data for accidents that occurred under daylight and night visibility conditions are presented in Figures 3A and 3B, respectively. Similar data are presented for accidents involving degraded visibility due to weather and dust in Figures 4A and 4B, respectively. Weather was involved in 14 (45.2 percent) of the orientation-error accidents. Of this total, 71.4 percent were fatal and 85.7 percent resulted in strike damage. The vast majority (92.8 percent) of these weather accidents occurred at night. Dust was involved in only one accident.

In Figures 5 through 9, summary listings are made of various aviator-related background information. For each figure, a separate compilation is made for each of the two Army pilots normally aboard the UH-1 aircraft. The terms "first pilot" and "second pilot" have been arbitrarily selected to identify the commanding aviator (not necessarily the senior-ranked aviator) and his copilot, respectively. Outside of Vietnam, the first and second pilot notation corresponds to the conventional pilot (P) and copilot (CP) identification. In Vietnam, however, the two aviators are usually identified as the air commander (AC) and pilot (P); the air commander rating applies only after an aviator gains a certain minimum of in-country experience within the air unit to which he is assigned. An air commander is thus identified as the first pilot and the pilot as the second pilot in this report. In the case of student aviators, the individual assigned to fly the aircraft at the time of the accident is identified as the first pilot.

Data pertaining to the military rank of the first and second pilots are shown in Figures 5A and 5B, respectively. Age distribution data for the pilots are listed in Figure 6. Aviator experience in terms of total flight hours both in all types of military rotary wing (RW) aircraft and in the UH-1 aircraft is described in Figures 7 and 8, respectively. The median for the total recorded RW experience was 887 hours for the first pilots and 400 hours for the second pilots. In terms of UH-1 flight experience, the median time was 550 hours for the first pilots and 175 hours for the second pilots.

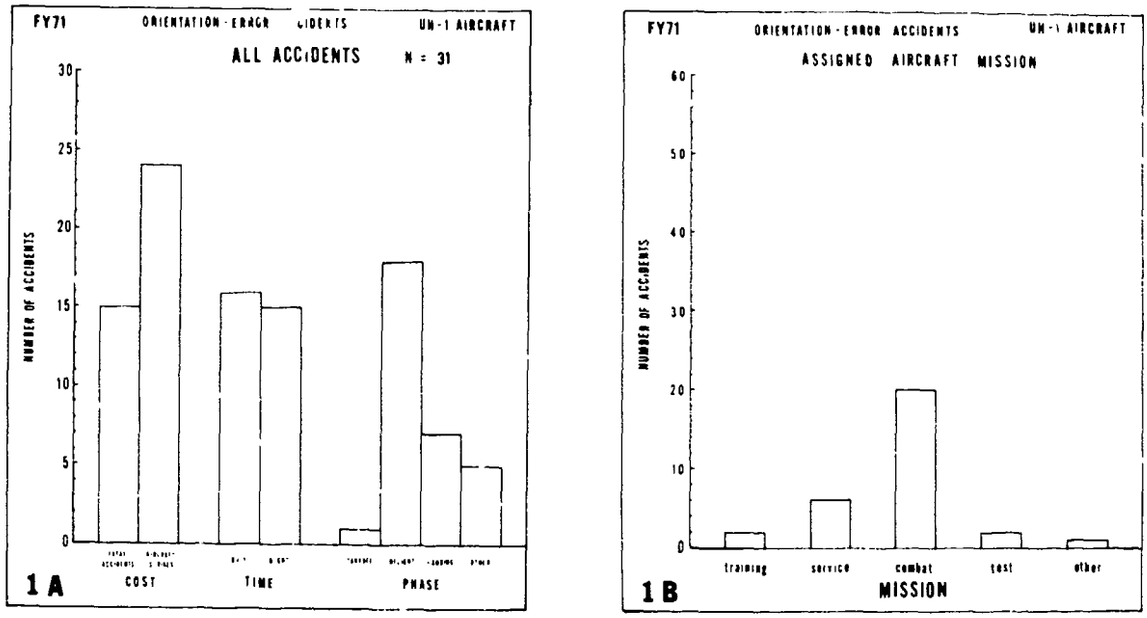

Figure 1

Major orientation-error accidents occurring in Regular Army UH-1 aircraft during fiscal year 1971. Number of fatal accidents, number of aircraft strikes, time of day of the accidents, and the flight phase in which the accident occurred (A); and type of missions assigned to the accident aircraft (B).

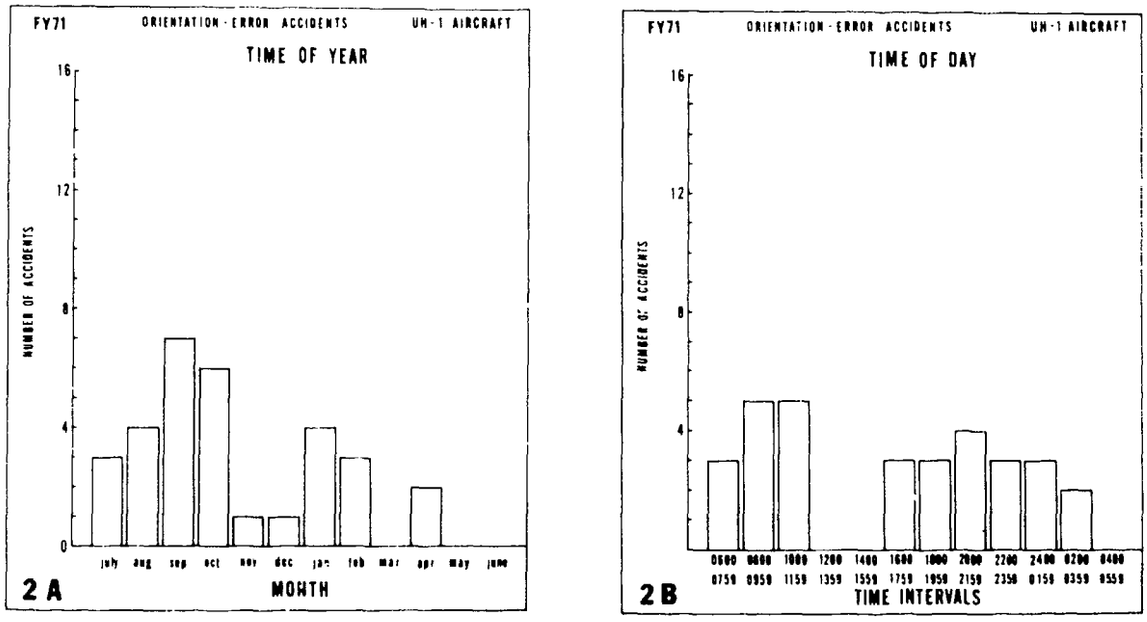

Figure 2

Number of orientation-error accidents as a function of the time of year (A) and the local time of day (B).

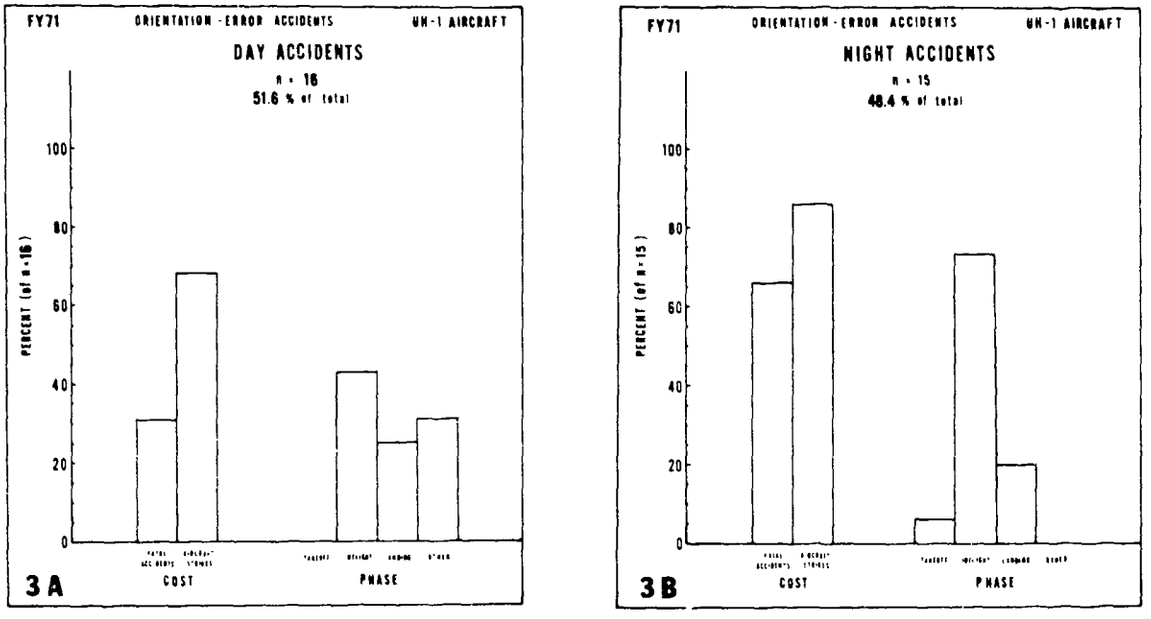

Figure 3

Comparison of percent incidence of fatal accidents, aircraft strikes, and flight phases for the 16 orientation-error accidents that occurred under daylight visibility conditions (A) and the 15 accidents that occurred under night visibility conditions (B).

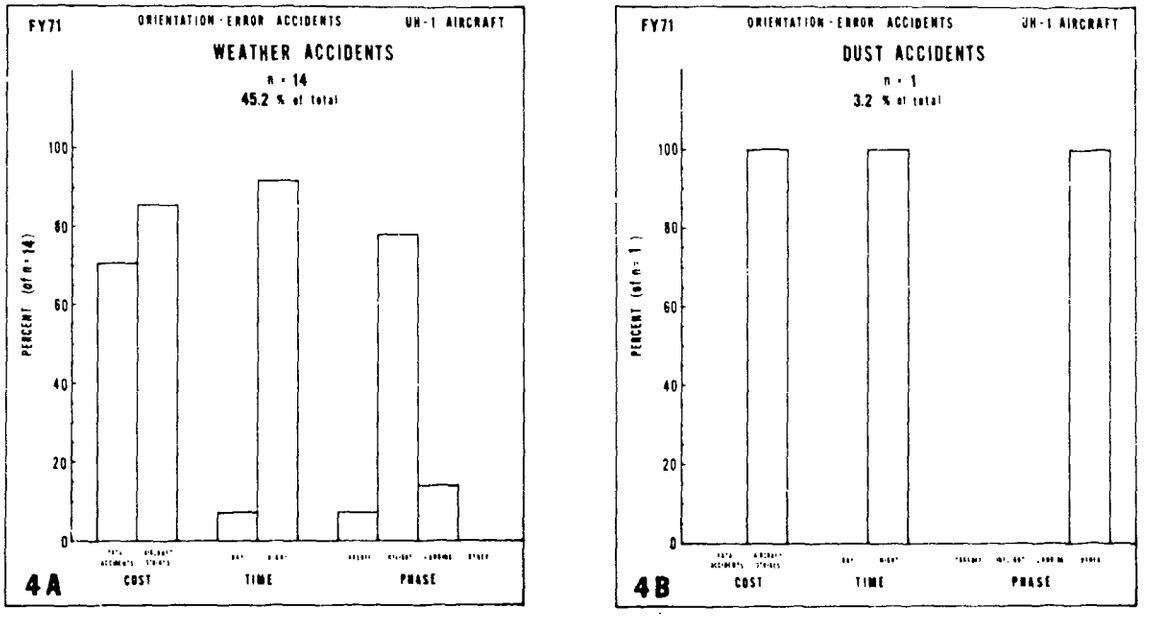

Figure 4

Percent incidence of fatal accidents, aircraft strikes, day/night accidents, and phases of flight for the 14 orientation-error accidents that involved poor weather (A), and the one accident that involved rotor-raised ground dust or ashes (B).

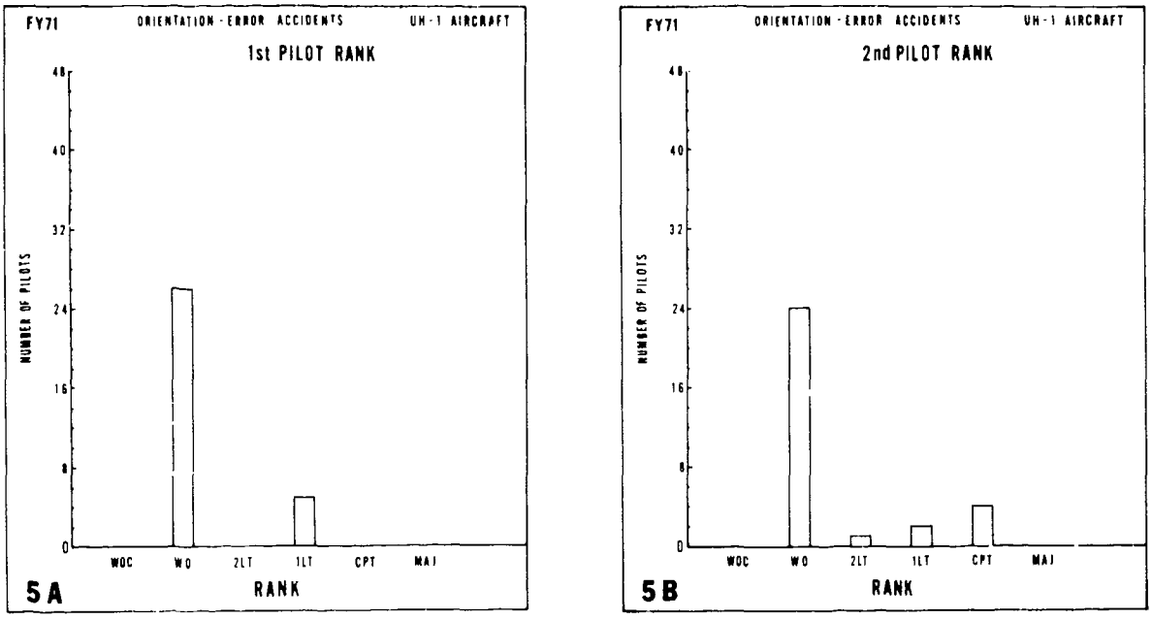

Figure 5

Distribution by rank of 31 first pilots (A) and 31 second pilots (B) involved in the orientation-error accidents. As explained in the text, the first pilot notation is used to describe the commanding aviator aboard the aircraft. In general, for Vietnam accidents, the first pilot is the "air commander" and the second pilot is the "pilot." For accidents occurring elsewhere, the first and second pilot notation usually corresponds to the conventional "pilot" and "copilot" designations, respectively.

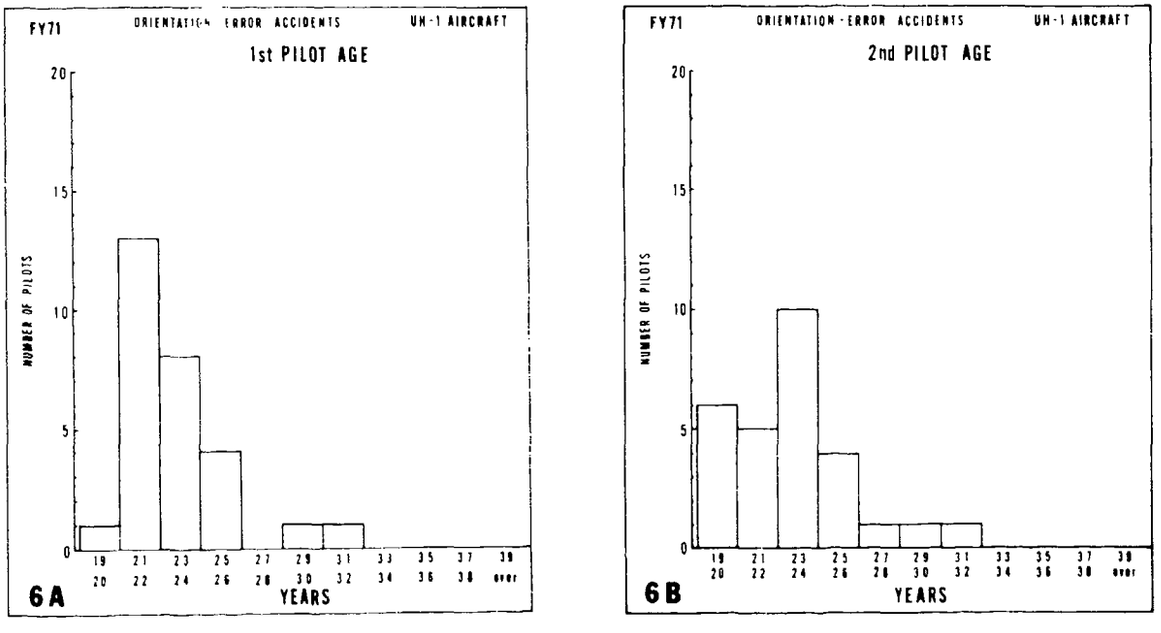

Figure 6

Age distribution of the first pilots (A) and second pilots (B). The median ages were approximately 23.0 and 23.6 years, respectively.

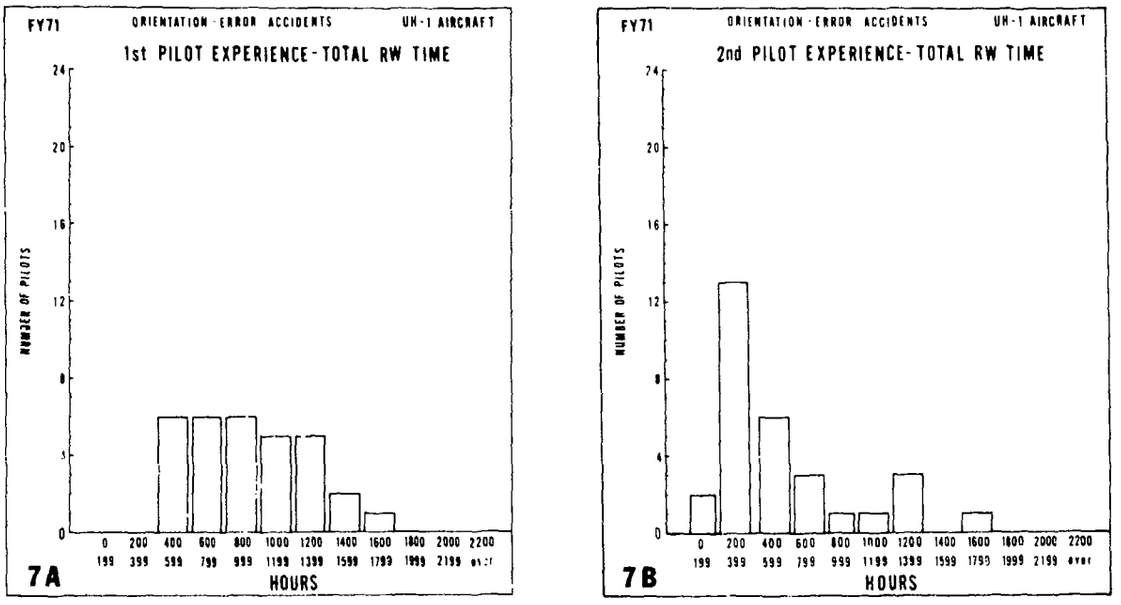

Figure 7

Distribution of total flight hours experience in military rotary-wing aircraft of the first pilots (A) and second pilots (B). The medians were approximately 887 and 400 hours, respectively. These data do not include any additional fixed-wing experience.

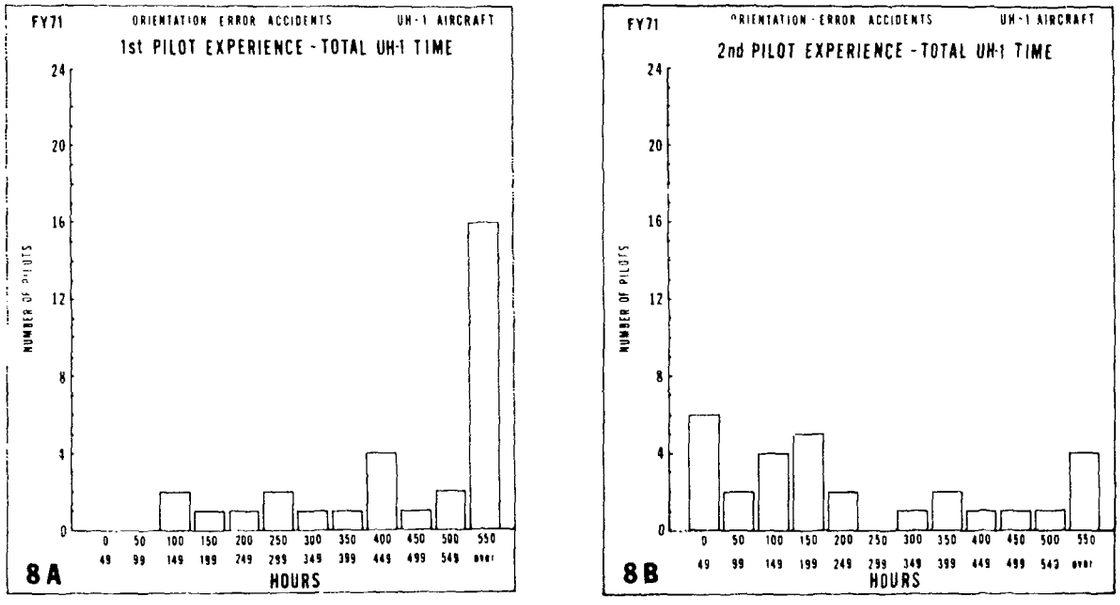

Figure 8

Distribution of total flight hours in the UH-1 aircraft of the first pilots (A) and second pilots (B). The median times were approximately 550 and 175 hours, respectively.

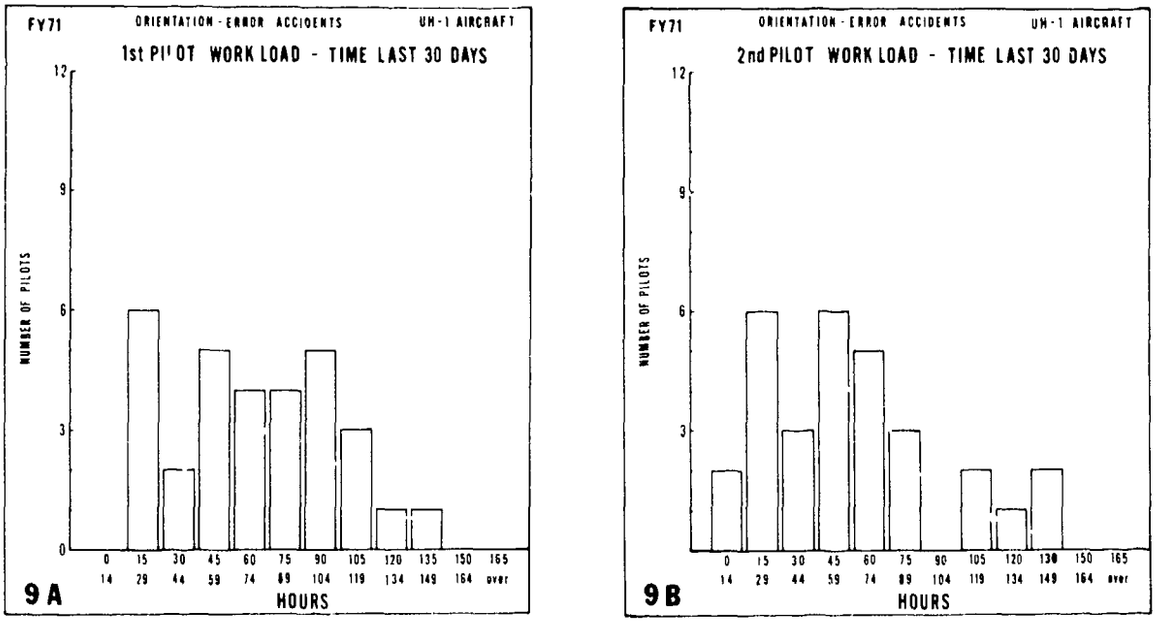

Figure 9

Distribution of pilot workload in terms of the total number of hours flown during the 30 days preceding the accident by the first pilot (A) and the second pilot (B). The median workloads were 69 and 55 hours, respectively. (See Figure 11 for related fatigue data.)

Workload data concerned with the total number of hours flown by the aviators the 30 days preceding the accident are shown in Figure 9. The median times were approximately 69 hours for the first pilots and 55 hours for the second pilots. Army regulations place 140 hours per 30-day interval as the official upper limit relative to pilot fatigue. After 90 hours, however, observation of the pilot by the air unit commander and flight surgeon is required.

To provide insight into the operational nature of these orientation-error accidents, the following pages contain a cursory case-history description of each individual accident. The first paragraph of each account lists in the designated order: accident location; the type mission assigned to the crew; the phase of flight in which the accident occurred; the time of day of the accident in terms of either night or daylight visibility conditions; the number of persons aboard the aircraft; the number of fatalities, major injuries, and minor injuries; and the presence of aircraft strike damage. The second paragraph presents a brief narrative of the accident proper.

A selected listing of the various factors derived from the review of the master accident files for these accidents is presented in Figures 10 through 14 on an individual case history basis. Once again the reader is reminded that the listing of any factor or event for a given accident is limited by the amount of data actually contained in the related master accident jacket. The format used in the preparation of Figures 10 through 14 is keyed to the identification of factors and events on an individual accident basis.

CASE BRIEF 71-1

United States: service mission--medical evacuation; flight phase--inflight; night flight; five persons aboard--one major injury and four minor injuries.

As visibility went IFR due to deteriorating weather, P initiated a right turn and decreased pitch in an attempt to stay VFR. During the turn, P experienced vertigo and transferred control to CP. As airspeed decreased P relieved CP at controls but again experienced vertigo and had to relinquish control a second time. Shortly thereafter, aircraft went into a dive. AC took control and began to climb out. He later stated, "During the climb, I was going into the right turn again and shortly after I felt and heard a loud crash." Aircraft impacted ground with little forward airspeed shortly after striking the tree tops.

CASE BRIEF 71-2

Vietnam: combat mission--assault; flight phase--landing; day flight; four persons aboard--one fatality and three minor injuries; aircraft strike damage.

With AC monitoring instruments, P made approach to pickup zone bordered by water. As approach terminated, tail rotor went low and impacted water resulting in aircraft rolling on its side. P had flown nine hours since last period of sleep which was for one hour. AC had flown 114 hours during the previous 30 days and had less than three hours sleep before accident flight.

CASE BRIEF 71-3

Vietnam: combat mission--medical evacuation; flight phase--inflight; day flight; four persons aboard--two minor injuries; aircraft strike damage.

Shortly after takeoff, master caution light came on. As AC examined panel to determine source of trouble, P in right seat initiated a climbing left turn to return to airfield. Aircraft actually descended during turn and impacted ground in a nose-low left bank attitude. Probable that P viewed panel during turn since he stated that lights were so dim it was difficult to identify malfunction. AC and P had flown 96 and 112 hours, respectively, during the previous 30 days. AC had flown 8.5 hours during the previous 24 hours.

CASE BRIEF 71-4

Vietnam: combat mission--support; flight phase--other; day flight; ten persons aboard--one minor injury.

Aircraft drifted backward into obstacle while at low hover prior to takeoff. AC and P had flown 112 and 130 hours, respectively, during the previous 30 days. Both pilots had been on duty for 10 hours and flown over 8 hours before this mishap.

CASE BRIEF 71-5

Vietnam: combat mission--assault; flight phase--other; day flight; nine persons aboard--two minor injuries.

AC had brought aircraft to a hover at a field landing site involving high grass and uneven terrain. Before troops could be discharged, aircraft drifted right with main rotor striking a tree. AC and P had flown 139 and 148 hours, respectively, during the previous 30 days.

CASE BRIEF 71-6

Vietnam: service mission--support; flight phase--inflight; day flight; five persons aboard--two fatalities and three major injuries; aircraft strike damage.

Aircraft departed airfield with P at controls and flew low-level along road to avoid air traffic. Terrain in the area was rolling with several rice paddies in vicinity. P initiated a sharp left turn and main rotor struck ground resulting in crash. AC stated he thought P had initiated a climbing turn.

CASE BRIEF 71-7

United States: training mission--night; flight phase--landing; night flight; three persons aboard--three fatalities; aircraft strike damage.

Weather started closing in as aircraft was seen returning to base on a wide extended approach at 1000 feet. Ground witnesses saw the aircraft enter or go behind a cloud, just as the aircraft was turning base. Seconds later, the aircraft reappeared in a steep descent. The aircraft pulled out of the descent and "climbed back into, or almost into, the clouds." Aircraft started another steep descent, extremely nose low, that continued until ground impact.

CASE BRIEF 71-8

Vietnam: combat mission--not defined; flight phase--inflight; night flight; four persons aboard--four fatalities; aircraft strike damage.

Without adequate weather analysis, crew initiated night flight at low altitude. As weather closed in, aircraft impacted trees at relatively high speed. AC and P had flown 93 and 112 hours, respectively, during the previous 30 days. AC had flown 8 hours during the previous 24 hours.

CASE BRIEF 71-9

Vietnam: test mission--weapons; flight phase--inflight; day flight; four persons aboard--one major injury and three minor injuries; aircraft strike damage.

AC flew several "race track" type patterns over test range at altitudes between 100 and 1000 feet while gunner and crew chief fired weapons. At an altitude of about 200 feet and an airspeed of 60 knots, a moderately steep left turn was initiated. During the turn, the AC attempted to reference a target to the right gunner. Aircraft impacted ground in a near-level attitude with the left skid slightly low.

CASE BRIEF 71-10

Vietnam: combat mission--support; flight phase--inflight; day flight; seven persons aboard--one major injury and two minor injuries; aircraft strike damage.

Aircraft made pass along beach trying to establish visual contact with ground unit. After locating unit, aircraft continued on course that carried it out over the ocean. At approximately 200 feet altitude, AC initiated a steep 180-degree right turn to return to ground site. AC did not detect loss of altitude that had occurred during turn and was unable to recover aircraft before tail rotor impacted water. AC and P had flown 93 and 88 hours, respectively, during the previous 30 days.

CASE BRIEF 71-11

Vietnam: combat mission--medical evacuation; flight phase--other; day flight; five persons aboard--no injuries; aircraft strike damage.

Aircraft arrived at pickup site where ground unit informed the crew that a hoist would be needed since trees would make a landing impossible. AC requested ground unit to move patients to a large clearing approximately 100 meters from site but was informed that the patients were injured too seriously to be moved. Aircraft then flown to nearby field to obtain hoist. On return flight to pickup zone, med-evac aircraft joined by two gunships and a single observer aircraft. Aircraft came to hover above trees and crew lowered hoist. Aircraft tail drifted right, struck trees, and crashed. Crew exited aircraft, carried patients to nearby clearing, and made evacuation using observer aircraft that landed following accident.

CASE BRIEF 71-12

Vietnam: service mission--ferry; flight phase--inflight; day flight; five persons aboard--three fatalities, one major injury, and one minor injury; aircraft strike damage.

Two aircraft flying along beach at low level when weather became marginal. When heavy rain encountered, lead aircraft executed a 180-degree turn inland. Second aircraft initiated a 180-degree turn out over ocean. Midway into turn, this aircraft impacted water with P stating their altitude was 50 to 75 feet at time turn was initiated.

CASE BRIEF 71-13

Vietnam: combat mission--medical evacuation; flight phase--inflight; night flight; four persons aboard--one fatality, two major injuries, and one minor injury; aircraft strike damage.

AC made takeoff into marginal weather at night with urgent child patient and mother aboard. Initially, flight made at low-level using searchlight. As visibility closed in, aircraft climbed to 1500 feet but had difficulty establishing contact with radar control. AC noted that his attitude indicator was indicating a left turn though the turn needle was centered. Tower contacted aircraft and informed crew that they had located their beacon. AC executed a left descending turn toward glow thought to be airfield. During descent, AC experienced vertigo and turned controls over to P. AC became reoriented at 1500 feet and came back on controls. Shortly thereafter both pilots experienced vertigo and both helped on controls climbing to 2000 feet where they encountered severe turbulence and rain. Pilots overcorrected and began to lose control of aircraft. Aircraft rolled over on its side and started descending at 2000 feet per minute. Pilots were able to slow descent to 500 feet per minute at an altitude of 600 feet. Attitude indicators were tumbling at this time and could not be read. Aircraft impacted ground shortly thereafter at same descent rate with little forward speed.

CASE BRIEF 71-14

Vietnam: service mission--search and rescue; flight phase--inflight; night flight; four persons aboard--four fatalities; aircraft strike damage.

At approximately 2200, crew of med-evac aircraft was notified that its sister ship was missing in marginal weather. Crew initiated search and rescue mission in heavy rain, flying at low level with landing light and searchlight turned on. Aircraft impacted ground during a right banking turn.

CASE BRIEF 71-15

United States: training mission--advanced; flight phase--other; day flight; two persons aboard--no injuries.

Relatively experienced P practicing autorotations misjudged altitude and attitude during flare resulting in tail rotor impacting ground. Flight surgeon made reference to P pterygium.

CASE BRIEF 71-16

Vietnam: combat mission--medical evacuation; flight phase--inflight; night flight; four persons aboard--three fatalities and one major injury; aircraft strike damage.

Crew departed on night med-evac mission to pick up urgent patient at landing site exposed to light rain. Aircraft was flying at 200 feet and 40 knots when visibility went IFR. AC initiated 180-degree left turn and P radioed control of their intent to return. Aircraft impacted water during turn while in steep bank.

CASE BRIEF 71-17

Vietnam: combat mission--medical evacuation; flight phase--inflight; night flight; five persons aboard--four fatalities and one minor injury; aircraft strike damage.

AC elected to attempt med-evac of urgent patient located at peak of mountain under adverse weather conditions. When aircraft arrived over site, light rain and a layer of scattered clouds surrounded mountain top. Ground troops provided illumination by firing mortars every 10 to 15 seconds. First approach was aborted when visual contact with site was lost. AC radioed ground unit to keep illumination constant. On second approach a dud mortar round resulted in loss of illumination for 10 or 20 seconds. AC decided to make a third go-around. A right turn was made away from the mountain. Loss of altitude during turn was not detected and aircraft impacted on the downward slope of the mountain.

CASE BRIEF 71-18

Vietnam: combat mission--Firefly; flight phase--inflight; night flight; four persons aboard--two fatalities, one major injury and one minor injury; aircraft strike damage.

Aircraft launched two flares at an altitude of 2500 feet to determine location of target area. AC then had Firefly lights turned on and descended to make a low pass gunnery run on position. At approximately 300 feet, the Firefly light was turned off. The AC continued the descent to 25 feet where he leveled off, turned on the searchlight, and saw a tree dead ahead. Aircraft impacted top of tree and crashed. Board mention of cockpit glare produced by high intensity lights.

CASE BRIEF 71-19

Vietnam: combat mission--assault; flight phase--landing; day flight; four persons aboard--no injuries; aircraft strike damage.

Aircraft was number five in a six-ship trail formation making a landing approach to a pickup zone adjacent to a rice paddy. AC allowed a tail-low attitude at the termination of the approach that resulted in a tail rotor strike on the dike. AC and P had flown 103.4 and 138 hours, respectively, during the previous 30 days.

CASE BRIEF 71-20

Vietnam: combat mission--medical evacuation; flight phase--landing; night flight; four persons aboard--two minor injuries.

Dustoff aircraft departed for pickup point in marginal weather - clouds at 300 feet and haze in some areas extending to the ground. Upon reaching the pickup point, the ground unit was asked to ignite a ground flare for positive identification. Following the ignition of two flares, the aviators asked that no more flares be used since it hampered their night vision. After circling the area twice, aircraft setup in a rectangular traffic pattern with field location marked by a single flashlight. As the aircraft turned onto final, the aircraft searchlight was turned on. At this time the aircraft was in a slight bank. Immediately after correcting for the bank, a tree was seen dead ahead. AC made pullup but tree broke both chin bubbles and left windshield. Aircraft was landed at pickup point without further difficulty. AC had flown 107 hours during the previous 30 days.

CASE BRIEF 71-21

United States: service mission; flight phase--inflight; night flight; three persons aboard--three fatalities; aircraft strike damage.

Crew had flown 12 hours during the previous 24 hours and were sleeping in aircraft when awakened and released for return to home base. Crew made hurried takeoff, encountering adverse weather conditions. Aircraft seen to make several turns with landing light on in apparent attempt to stay VFR. Soon thereafter aircraft impacted ground in a steep, nose-low attitude.

CASE BRIEF 71-22

Vietnam: undefined mission; flight phase--inflight; day flight; four persons aboard--two fatalities and two major injuries; aircraft strike damage.

Aircraft departed from formation and flew over bay at low altitude (five feet above water) toward destroyer. Upon reaching the stern of the ship, the AC made a cyclic climb to 200 feet and executed a sharp left turn. Upon completion of the turn, a power dive was initiated parallel to the starboard side of the destroyer. Recovery from the dive was not initiated until it was too late and the aircraft impacted the water in a near-level attitude.

CASE BRIEF 71-23

Vietnam: combat mission--assault; flight phase--landing; day flight; four persons aboard--two minor injuries; aircraft strike damage.

P made slow and shallow approach to pickup zone over water-covered rice paddy bordered by high grass. AC thought approach was normal at a safe altitude when tail rotor impacted water. AC had flown 132 hours during the previous 30 days.

CASE BRIEF 71-24

Vietnam: combat mission--assault; flight phase--other; day flight; four persons aboard--no injuries.

AC lifted aircraft to a low hover prior to backing out of revetment. Forward visibility limited by morning sun and fog still on windshield. As aircraft was backed, the nose began an undetected yaw to the left that resulted in a tail rotor strike on the revetment.

CASE BRIEF 71-25

Europe: service mission--ferry; flight phase--inflight; night flight; three persons aboard--one major injury and two minor injuries; aircraft strike damage.

P made takeoff at night without adequate weather analysis. Climbed to an altitude of 1500 feet and initiated a turn as the ceiling dropped. Aircraft entered a thick fog layer at completion of turn and P stated he applied power to climb to a higher altitude. Shortly thereafter, aircraft impacted ground in a tail-low, left-bank attitude. Report references searchlight reflections in fog and possibility of flicker vertigo.

CASE BRIEF 71-26

Vietnam: combat mission--support; flight phase--inflight; night flight; four persons aboard--three major injuries and one minor injury; aircraft strike damage.

P had flown six hours during day. After his first "Nighthawk" gunnery mission of the night, he felt fatigued and slept for 2 1/2 hours. On second Nighthawk mission, AC experienced vertigo when visibility went IFR at 700 feet during a climb initiated under GCA control. AC stated, "I was just about to inform GCA when I got vertigo. I told the P to take it which he did. I cannot say what type of attitude the aircraft was in at the time I gave it to him. I was trying to get myself around when the rpm warning light or audio caught my attention and my eyes came across the instruments. The VSI was giving over a 1000 feet/minute climb. I was yelling at the P about power when I saw the torque coming down past 60 pounds. We leveled off at 2700 feet. I took the controls back. At this time I noted I had in right cyclic but my attitude indicator said I was flying straight and level. GCA said I was turning and to turn left to a heading. When I did this we started spinning. I told the P to take it. He did and told me to get off the controls. Again the ship started to spin which threw me right forward in my seat. I said we were going to crash. Then for a second I saw lights and trees. We went in a left bank. I pulled right aft cyclic and power. I said we are going into the trees. Next thing I knew we were upside down in the trees." AC had flown 104 hours during the previous 30 days.

CRASH BRIEF 71-27

Vietnam: combat mission--medical evacuation; flight phase--inflight; night flight; seven persons aboard--seven fatalities; aircraft strike damage.

Aircraft made night emergency evacuation under adverse weather conditions of wounded patient carried on a special sling suspended beneath the aircraft. Observer saw aircraft enter clouds in an unusual flight attitude. Shortly thereafter, aircraft struck ground in a nose-low, steep right-turn attitude. Pilot of another aircraft flying near the accident aircraft stated, "As the aircraft came up, he was in a fast ascent and went straight into the clouds. I heard a voice I recognized as the CP of the aircraft say, 'Your power, watch your power!' I then called the P and asked how he was doing. He said he was at 5000 feet and had vertigo twice already but that he was on a GCA approach." Aircraft ADF equipment inoperative before takeoff.

CASE BRIEF 71-28

Vietnam: combat mission--medical evacuation; flight phase--landing; day flight; five persons aboard--no injuries.

With CP at controls, approach made to pickup site bordered by insecure rice paddies. When location of patients was determined, a hovering turn was made so as to land nearby. Tail rotor impacted ground during turn. AC and P had flown 16 and 10 hours, respectively, during the previous 24 hours.

CASE BRIEF 71-29

Vietnam: combat mission--medical evacuation; flight phase--takeoff; night flight; four persons aboard--four fatalities; aircraft strike damage.

Aircraft assigned a night med-evac mission under adverse weather conditions. During takeoff, aircraft seen to initiate a left turn as it entered fog. Ship gradually descended during turn and impacted ground.

CASE BRIEF 71-30

Vietnam: test mission; flight phase--inflight; day flight; four persons aboard--one fatality, one major injury and two minor injuries; aircraft strike damage.

After completing several med-evac missions, AC decided to make a short test flight to check rotor spin during autorotation which had been written up in log book as having a tendency to build. AC performed autorotation over water and came to a hover near a beach without difficulty. He then climbed to 1000 feet and initiated a steep left bank and dived toward the water. Delayed attempt to recover from dive resulted in aircraft striking water in an almost level attitude.

CASE BRIEF 71-31

Vietnam: combat mission--medical evacuation; flight phase--landing; night flight; four persons aboard--four minor injuries; aircraft strike damage.

Dustoff aircraft assigned night med-evac mission to pick up urgent patient. After establishing contact with ground unit, decision made to approach in direction away from last contact with enemy. Approach made to jeep-lighted pickup zone, known by both aviators to be dusty, with landing light and searchlight turned on. As approach terminated, visibility became restricted due to rotor-raised dust. When aircraft drifted forward toward a radio antenna, the AC was instructed to move ship backward and to the left. Loss of altitude not detected and tail rotor impacted ground with left skid low.

In each of these figures, a separate vertical column is assigned to each accident where the number at the top of each column corresponds to the accident number used to sequentially identify the individual case history briefs presented earlier. An alpha-numeric index code is used to identify selected accident factors where an x-entry denotes the presence of the related factor. In addition to these individual listings, the total number of accidents in which a given factor was present is tabulated in a separate column. Reference should be made to the first report (ref. 3) of this series for details pertinent to the basic classification criteria used for the listed factors.

Figure 10 summarizes various accident/aviator background information associated with these 31 fiscal year 1971 orientation-error accidents. The location of each accident is denoted in rows A1 through A3. For that fiscal year, 83.9 percent of the UH-1 orientation-error accidents occurred in Vietnam. Rows A4-A8 denote the model of the aircraft, A9-A13 indicate the mission assignment, A14-A17 the phase of flight in which the accident occurred, and A18 and A19 the time of day in terms of daylight or night visibility. Under the miscellaneous heading, A20 denotes those accidents in which one or more fatalities were involved. Row A21 indicates those fatal accidents in which all personnel aboard the aircraft were killed. Entries in row A22 indicate accidents resulting in a total loss or strike of the aircraft. In contradistinction, entries in A23 denote accidents resulting in minimal damage, i.e., the accidents in which the total dollar damage was less than $25,000, which amounts to approximately 10 percent or less of the replacement cost of the aircraft. The B and C headings in Figure 10 give data relative to the background and experience of the first and second pilots, respectively. The interpretation of the experience data contained in rows B5-B9 and C5-C9 should be related to the distribution data previously presented in Figures 7 and 8, which pertain to only total RW time and total UH-1 time. Rows B5 and C5 denote those aviators who had a total FW (fixed wing) and RW experience of 1000 hours or more. In terms of only RW flight time, entries B6 and C6 denote those aviators with 1000 hours or more of RW experience. In the opposite direction, entries B7 and C7 identify aviators with less than 400 hours RW time, denoting minimal experience. Relative to total time in the UH-1 aircraft, entries B8 and C8 denote aviators with greater than 500 hours, while B9 and C9 denote those with less than 100 hours. To gain insight into the availability of post-flight data from the aviators involved in the accident, entries B10 and C10 indicate those pilots fatally injured. Data pertaining to other accidents the pilots may have been involved in are listed in entries B11 and C11.

The factor and event data presented in Figures 11 through 14 follow the Figure 10 format with the row entries continuing to be identified in alphanumeric sequence. It should be observed that Figures 11 and 12 are concerned with factors and events which were listed as being present, or having happened, in the time period preceding takeoff; Figures 13 and 14 list factors and events which occurred, so far as the crew were concerned, only after the aircraft became airborne. This approach has been selected with the long-term objective of possibly distinguishing between accidents that may occur as a result of initial conditions existing before flight, and accidents that may occur seemingly as a result of only some inflight event or factor.

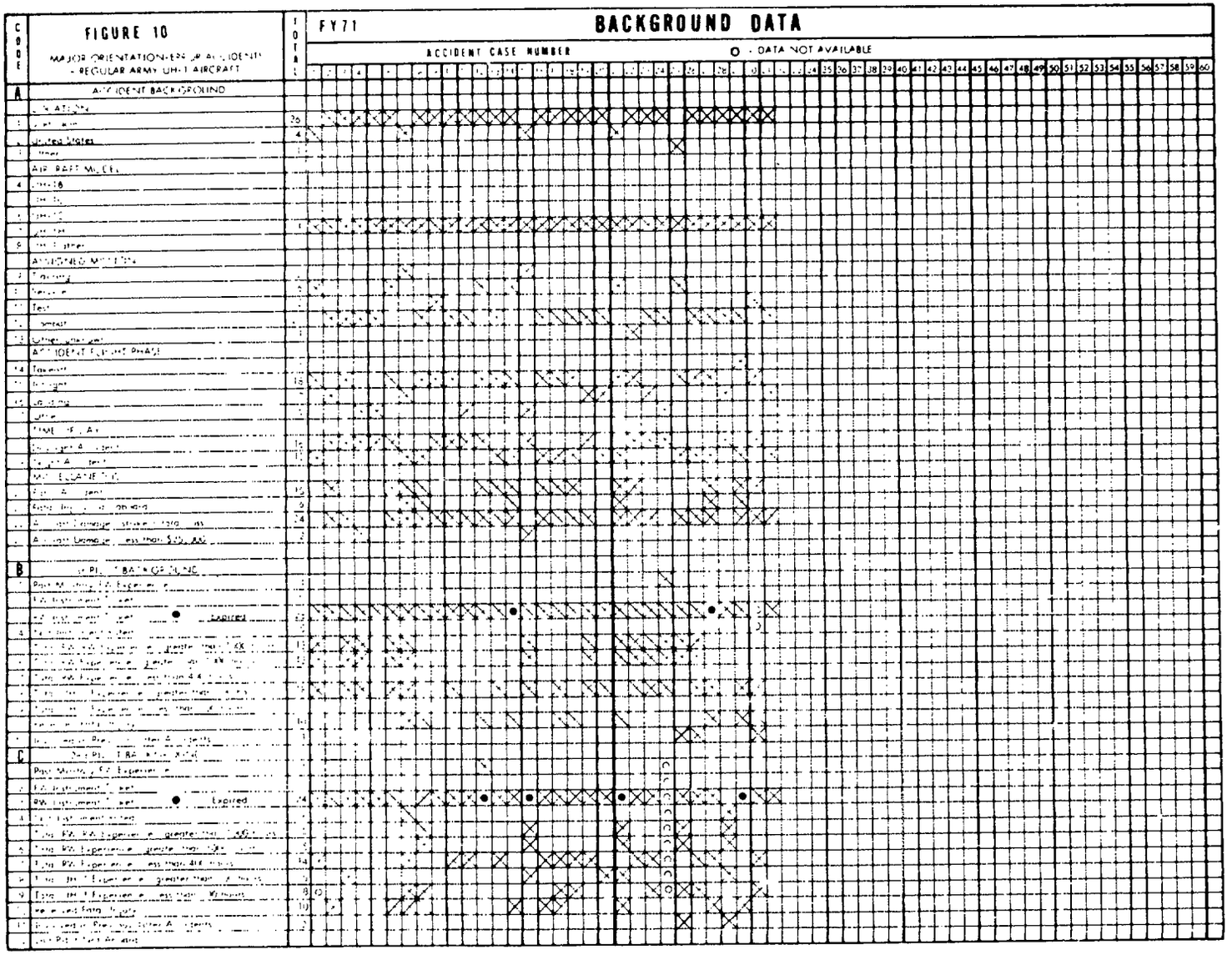

Figure 10

Individual case history listing of basic accident details and selected aviator background information.

In Figures 11 and 12, factors and events which were present before takeoff are listed under physiological, psychological, facility, supervisory, materiel, mission pressure, pilot preflight, and miscellaneous factor headings. The D and F headings pertain to physiological and psychological factors, respectively, associated with the first pilot while the E and G headings list the same factors for the second pilot. This separate listing allows a heavier weighting to be given these factors when both pilots, rather than only one, experience the related difficulties.

Relative to physiological problems that existed prior to takeoff, fatigue was found to be the most obvious factor. Four entries, D1-D4 for the first pilot and E1-E4 for the second pilot, have been allotted to the description of this problem. Entries D1 and E1 denote aviators with greater than 140 total flight hours during the 30 days preceding the accident. Army regulations for Vietnam flight operations set this figure as the upper limit which cannot be exceeded except during tactical emergencies. Although it is possible to obtain permission at the battalion level to exceed this limit, the regulations direct the commanders to use the utmost discretion when granting this waiver. For fiscal year 1971, only one accident involved an aviator who had flown more than 140 flight hours the preceding 30 days. The same Army regulations also state that a crew member who accumulates 90 hours in a 30-day period will be closely monitored by the unit commander and the flight surgeon. This monitoring requirement is thus an implied recognition of individual susceptibility to fatigue. For this reason, the authors have chosen to also identify those accidents involving aviators with a workload greater than 90 hours, and less than 140 hours during the preceding 30 days. The related D1-D2 and E1-E2 fatigue entries indicate 10 first pilots and 4 second pilots experienced this workload. There were 10 (32.2 percent) accidents in which either one or both of the aviators had flown more than 90 hours during the 30-day period preceding the accident. Of this total, 5 (16.1 percent) accidents involved the case where both aviators had flown more than 90 hours during the preceding 30 days. A third fatigue classification, D3-E3, involves the identification of aviators who had flown 8 hours or more the 24 hours preceding the accident. Five first pilots and 5 second pilots experienced this workload. In entries D4 and E4, miscellaneous fatigue factors mentioned by the accident board, for example, long duty hours or interrupted sleep, are listed. Treating the four fatigue entries as a group, there were 12 (38.7 percent) accidents in which at least one aviator was exposed to one or more of the stated fatigue listings.

The F and G psychological factor listings are intended to identify any unusual mental attitude or condition that existed before the aircraft actually became airborne. As stated previously, it is the opinion of the authors that the field accident investigation teams seem to be reluctant to enter psychological information into the written record. Very little information has been gained under this classification.

The H facility factor heading is used to denote any airfield shortcomings which the accident board considered to have some effect on either the accident proper or the course of flight action available to the pilot. The facility factors listed under this heading, distinct from those listed under the P heading in Figure 13, relate to shortcomings present before actual takeoff of the aircraft. Factor I deals with supervisory

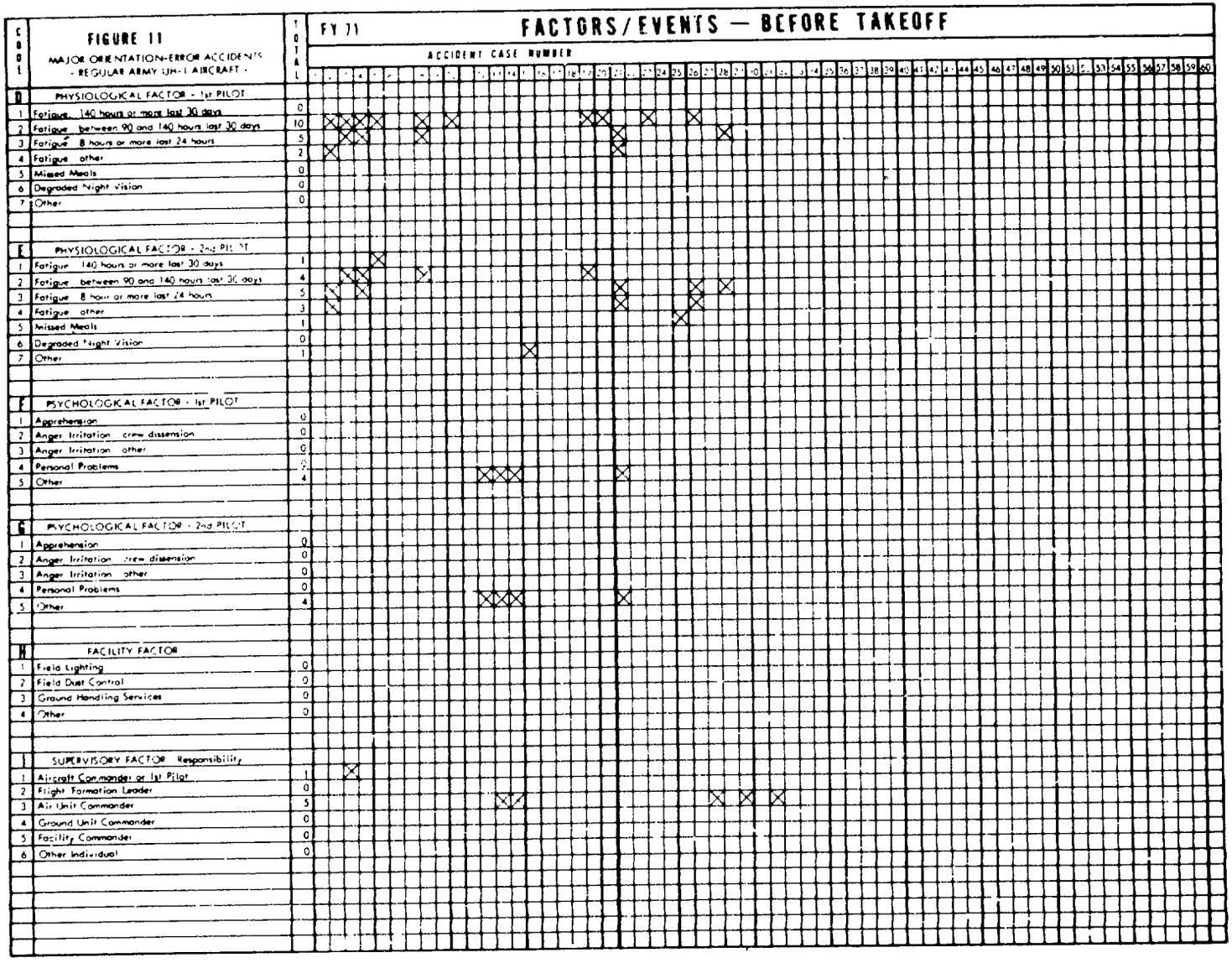

Figure 11

Individual case history listing of selected accident factors and events present before, or at the instant of, takeoff on the accident flight. See text for details.

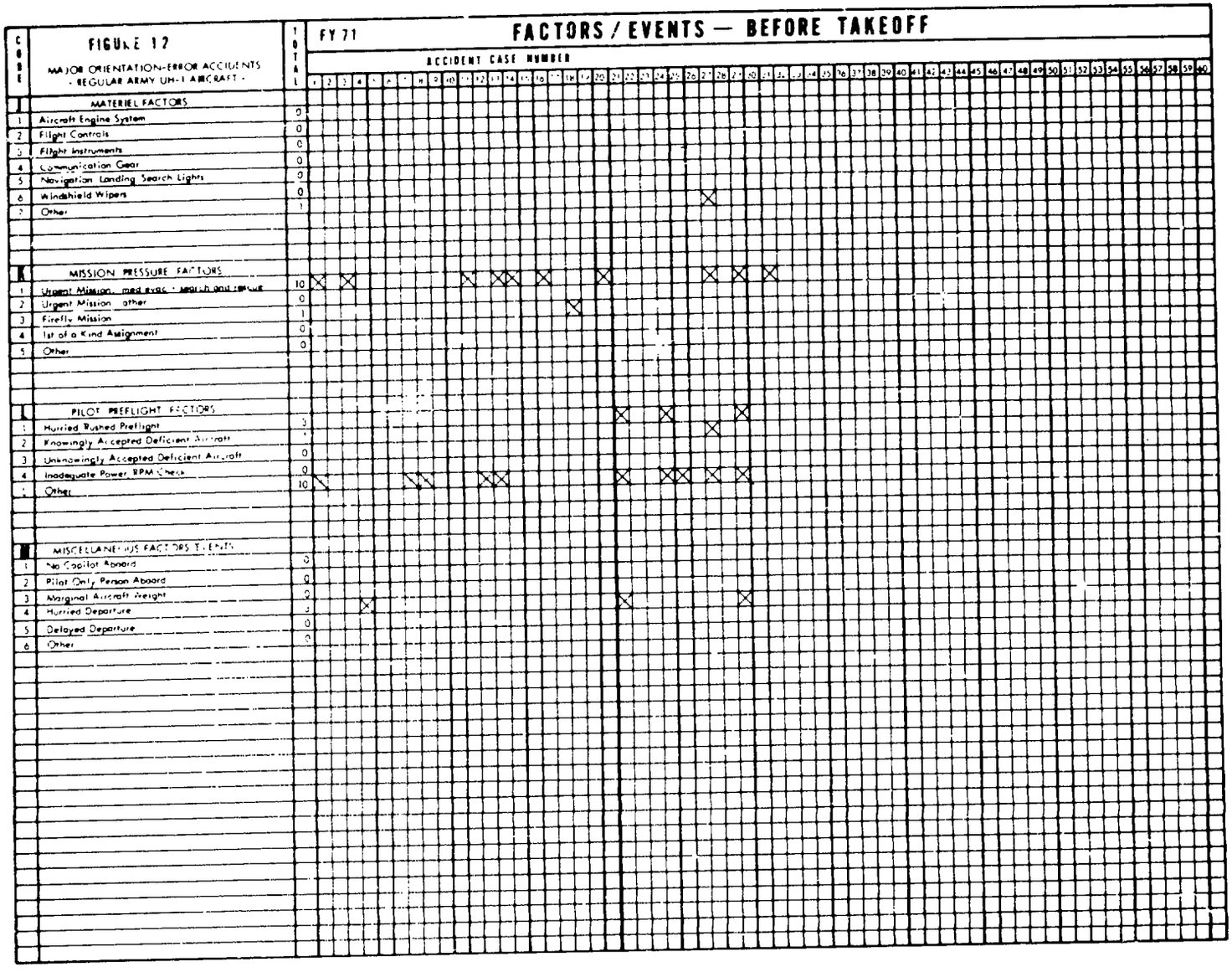

Figure 12

Continuation of the Figure 11 listing of before-takeoff factors and events.

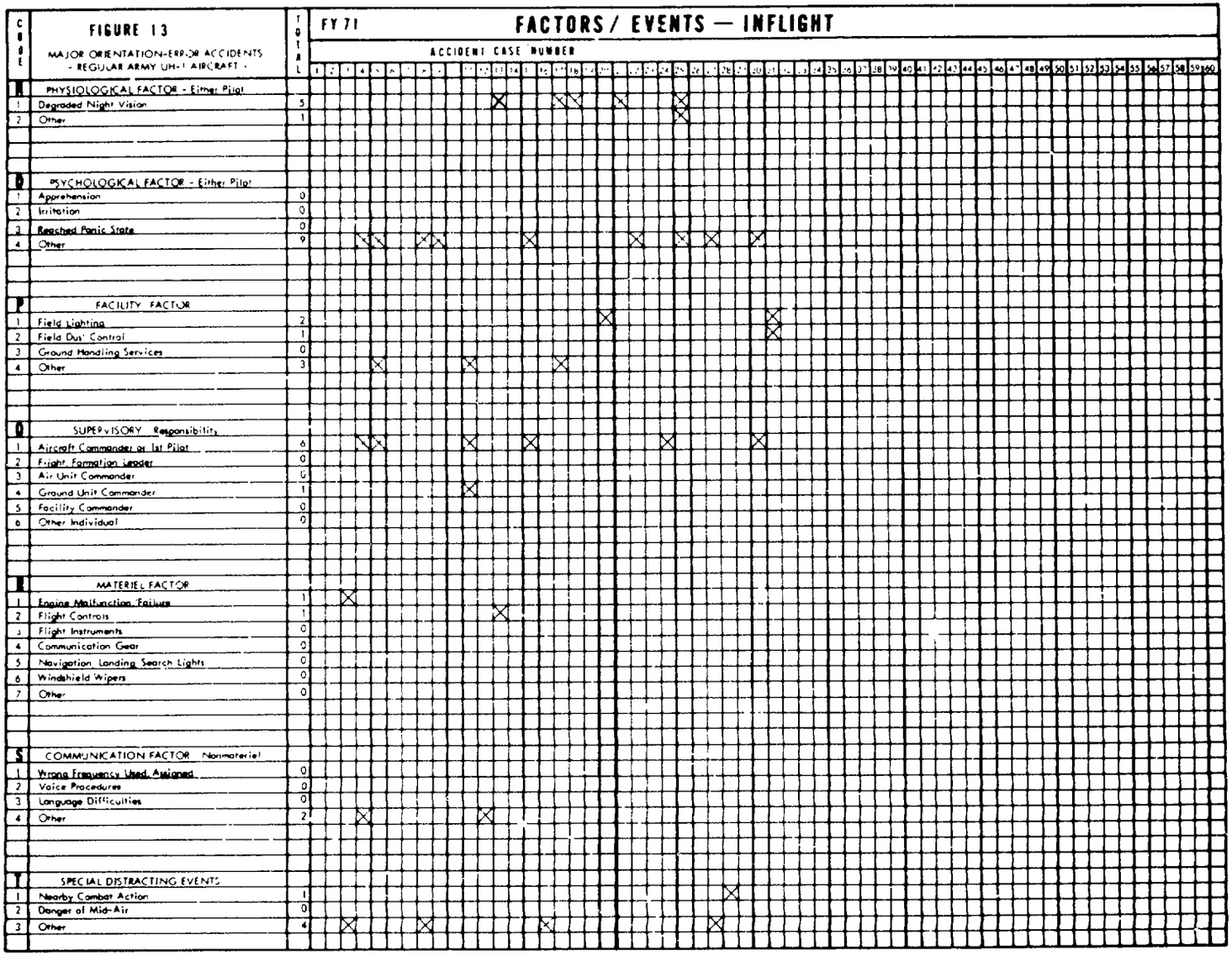

Figure 13

Individual case history listing of selected accident factors and events considered to have occurred, or to be first manifested to the crew, while the aircraft was in flight.

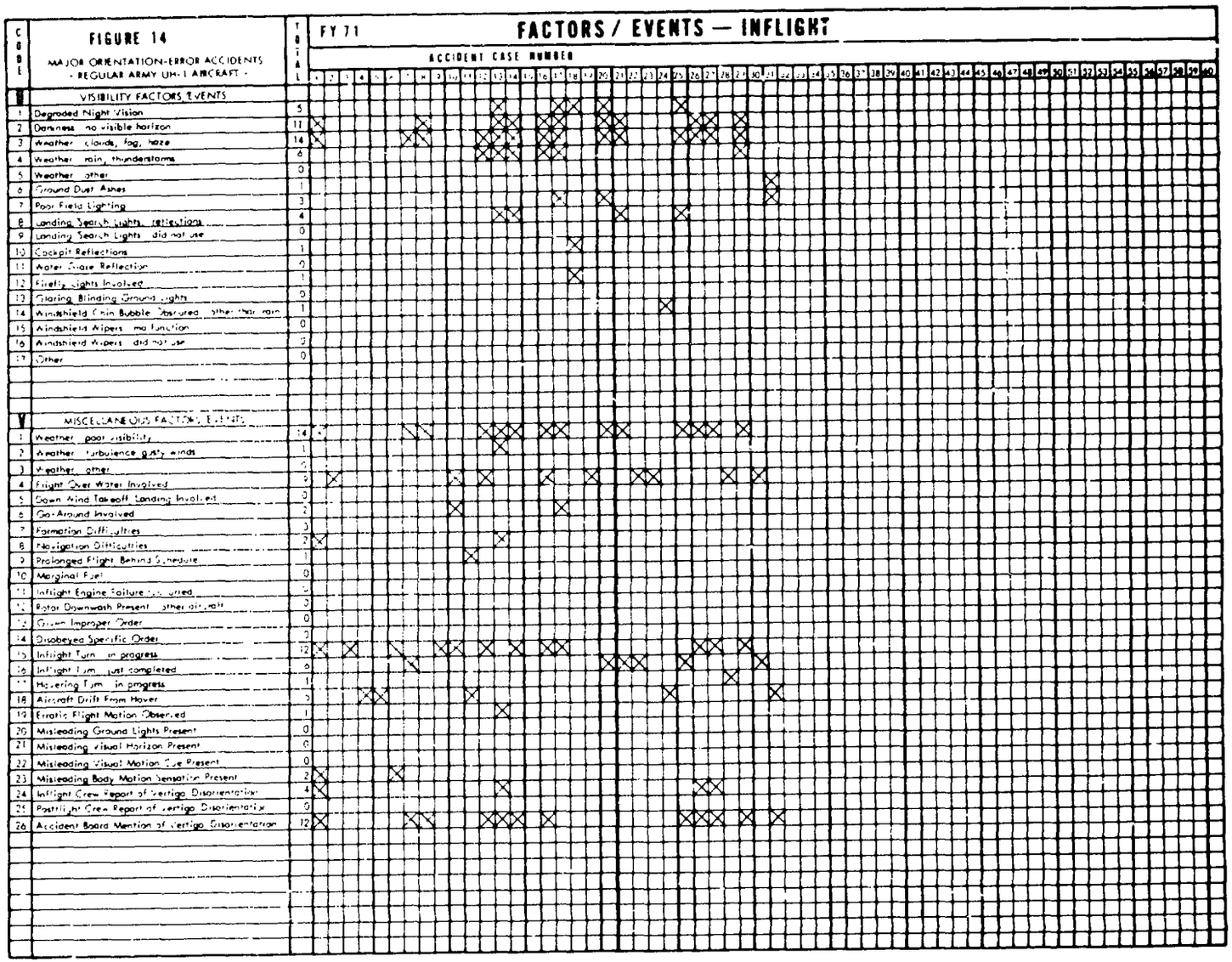

Figure 14

Continuation of the Figure 13 listing of inflight factors and events.

errors which were considered by the accident board to have taken place before the flight became airborne. The listings under this heading denote the individuals assigned primary responsibility for this error.

Materiel deficiencies that existed before takeoff are listed under the J heading in Figure 12. The function here is to identify the accident situation where a materiel factor was known to be present, but not necessarily known to the aviators, before the aircraft became airborne. These factors are distinguished from the materiel failures that may have occurred while inflight and are listed under the R heading in Figure 13. It should be observed that an entry in one of the J listings does not imply that the materiel deficiency necessarily affected or effected the accident. The only implication is that there was some difficulty associated with the listed materiel item.

The K mission pressure heading is included as a preflight factor in an attempt to weight the crew's concept of the importance, the uniqueness, or the urgency of the mission. Though such a stress factor could be properly listed under the psychological heading, a separate listing is provided to distinguish among various operational situations. Section L deals with the crew preflight of the aircraft. The L1 entry denotes a hurried or rushed preflight situation, and as noted previously, entries L2 and L3 indicate the pilot's knowledge of any materiel problems that existed prior to takeoff. The objective here is to establish different factor weights for the situation where the pilot knows in advance that his aircraft is not fully operational, and for the situation where this operational deficiency is not recognized until after the flight becomes airborne. The section M heading is reserved for miscellaneous factors, events, or conditions that may have been present at the time of or before takeoff.

Factors similar to those in Figures 11 and 12 are outlined in Figures 13 and 14 but apply to the inflight phase of the 31 accidents. The N physiological factor and O psychological factor headings pertain to either pilot in this section since the preliminary accident review indicated that, in general, the inflight occurrence of such factors affected both pilots. Section O is a listing of psychological factors that were coded as occurring inflight. A point of consideration relative to the minimal number of listings contained under the inflight psychological factors heading is that all of the non-normal incidents and events that occur inflight, whether they involve some materiel problem, some communication difficulty, or some change in visibility, can certainly affect the mental outlook of the crew. In this respect, the majority of the factors listed under all the other headings will have some psychological input.

The P facility factor heading denotes airfield shortcomings or limitations that affected the accident proper, or the course of action available to the pilot, while the flight was airborne. Though certain of these facility factors involved field sites rather than established heliports, it was the opinion of the accident board that it was reasonable to expect that the specific difficulty could have been prevented. Personnel responsible for inflight-related supervisory errors are denoted under the Q heading.

Section R deals with materiel malfunctions or difficulties that were encountered

while the flight was airborne. Materiel malfunctions outlined previously in the before-takeoff phase under the J heading are not entered here unless an attempt was made to use the defective materiel item while inflight. Section S describes inflight communication factors that were nonmateriel related. Only one accident involved this factor. Section T deals with special distracting events that the pilots encountered while airborne.

Section U deals with the key initiating factor in orientation-error accidents -- pilot visibility. In 17 (54.8 percent) of the 31 accidents, degraded visibility in one form or another was involved. A variety of miscellaneous factors and events related to the accidents are listed in section V. The V24 entries indicate that in 4 accidents, the crews recognized, while inflight, that they were experiencing orientation error manifested classically as vertigo or disorientation. As shown by V26, the accident investigation teams or reviewing authorities made specific mention of either pilot vertigo or pilot disorientation in 12 (38.7 percent) of the 31 orientation-error accidents.

This report completes the compilation of accident factor data for the fiscal year 1967 through 1971 period. A final report will be prepared to summarize the over-all findings of this five-year longitudinal study of orientation-error accidents in the UH-1 military aircraft.

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Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY (Corporate author) Naval Aerospace Medical Research Laboratory Pensacola, Florida 32512	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP N/A

3 REPORT TITLE

MAJOR ORIENTATION-ERROR ACCIDENTS IN REGULAR ARMY UH-1 AIRCRAFT DURING FISCAL YEAR 1971: ACCIDENT FACTORS

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)

5 AUTHOR(S) (First name, middle initial, last name)

W. Carroll Hixson and Emil Spezia

6 REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
7 July 1975	26	14

8a. CONTRACT OR GRANT NO	9a. ORIGINATOR'S REPORT NUMBER(S) NAMRL-1219
b. PROJECT NO NAVMEDRSCHDEVCOM MF51.524.005-7026	
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) USAARL Serial No. 76-1
d.	

10 DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11 SUPPLEMENTARY NOTES	12 SPONSORING MILITARY ACTIVITY
Joint report with U. S. Army Aeromedical Research Laboratory, Fort Rucker, Alabama	

13 ABSTRACT

This report is the fifth in a longitudinal series of reports dealing with the pilot disorientation/vertigo problem in Regular Army UH-1 helicopter operations. Individual case history data extracted from the USAAAVS master aircraft accident files are presented on major orientation-error accidents that occurred in UH-1 aircraft during fiscal year 1971. Summary data listings involving a variety of operational and pilot-related accident factors are presented for each of the 31 cases. The listings are arranged to distinguish between those factors and events present before takeoff, i.e., the initial conditions associated with a given accident, and those which occurred or were manifested during the actual airborne phase of the accident flight.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6801

Unclassified
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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Army aviation						
UH-1 helicopters						
Aircraft accidents						
Aviation safety						
Aviation medicine						
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